The Evolution of a Cardiology Information System: From Mainframe to Web

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Background. Fifteen years ago, the requirements for an electronic medical information system were constrained by the available tools. A good database schema combined with a functional user interface was considered sufficient. Today's tools and environments not only obsolete yesterday's systems, but also obsolete yesterday's methodologies. To keep up with the desires and wishes of today's more computer savvy users, medical information systems must be modular, configurable, and able to conform to new and emerging platforms. We present a Cardiology Information System that has grown from its origins as a mainframe environment of the seventies to networked PCs in the eighties to a modular, customizable PC system with capabilities for Internet access.

System. While existing in many different forms, the MUSE (Marquette Universal Storage for Electrocardiography) Cardiovascular Information System (CVIS) has been in existence for over 15 years. Early MUSE systems were based on the DEC PDP-11/34 and were capable of acquiring, analyzing, and storing ECG's; the current MUSE Cardiovascular Information System operates as a series of networked PC's operating from a Windows NT file server.

The current MUSE supports 16 different Cardiology data types including Cardiac Catheterization, Cardiac Surgery, and Nuclear Medicine, as well as the original MUSE Cardiology data types of Resting ECG, Pacemaker ECG, Exercise and Holter testing. For each data type, all textual report data, signal report data (e.g., ECG and hemodynamic waveforms) and image report data (e.g., Cardiac Catheterization x-ray images), can be displayed within the MUSE editor and printed from MUSE. The user can customize the appearance of the editor screens, the appearance of the final reports and can add customer-specific fields to the MUSE database.

With the introduction of a Web interface, MUSE reports can now be viewed on any computer platform that supports a web browser. Developed using the MUSE programmer's API, the MUSE Web application presents the user with the ability to select a patient, a test for the patient, and then to view the final report for that test. We have found the best results for the transmission and display of the final report to be the Adobe Portable Document Format. The PDF format was selected from the dozen different transmission types supported by the MUSE Web application. These outputs vary from raster bitmaps such as JPEG to printer specific vector formats such as PostScript and PCL5. The PDF format allows us to display our printed reports formats on remote workstation monitors in an appearance identical to the printed page. As a vector page format, waveform and image data on the PDF report will scale as the resolution of the display improves; and, the size of the transmitted report is no larger, and in many cases is smaller than a compressed raster bitmap image.

Evaluation. No software application is ever complete. With a flexible PC-based platform with Internet access via our web application, the MUSE is a very useful tool. However, enhancements are always planned. Included in these are improvement of Web capabilities such as editing of report data, data warehousing to provide sophisticated off-line searches without impacting daily performance; MUSE CVIS connectivity to palmtop computers; and increased accessibility for third-party tools

Conclusions. We have developed an application that is both powerful and flexible. With the capability of editing, viewing, and storing many different types of Cardiology data, the usefulness of our application is established. With the ability to redefine the interface, extend the database, and provide remote access, the utility of our application is established. We have developed a platform from which we can continue to provide our users with an application that evolves with the continuously rapidly changing computer industry.

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